



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

No.	Thickness.	Strata.	Elevation above well.
1	1 foot.	Limestone.....	104 feet.
2	5 feet.	Shale.....	103 "
3	2 "	Limestone.....	98 "
4	4½ "	Shale.....	96 "
5	3½ "	Limestone.....	91½ "
6	37 "	Shale.....	88 "
7	1½ "	Limestone.....	51 "
8	1 "	Shale.....	49+ "
9	3½ inches.	Coal.....	48+ "
10	21 feet.	Shale.....	48 "
11	6½ "	Limestone.....	27 "
12	15½ "	Shale.....	20½ "
Shale and river bottom land join.....			5 "
Santa Fe depot at Madison.....			3 "

The depths of the Mississippian below sea-level are: At Neodesha, 135 feet; at Fredonia, 310 feet; at Fall River, 430 feet.* At Toronto, a well 1452 feet deep did not quite reach the Mississippian.† At Madison, hard rock, supposed to be the Mississippian, was struck at 820 feet below sea-level. The dip toward Madison is therefore about ten feet per mile from Fall River; eleven feet per mile from Fredonia; and twelve feet per mile from Neodesha. The dip from La Harpe is between seventeen and eighteen feet per mile. From Ottawa it is about sixteen feet per mile.

At Madison the Cherokee shales are 460 feet thick, while at Toronto they are more than 372 feet thick. The Pleasanton shales are much heavier at Toronto than at Madison. Above this to the top of the Iola limestone these two wells differ very little. Above the Iola a bed of shale 104 feet thick at Toronto corresponds to a bed of sandstone 172 feet thick at Madison. The limestone above these beds is 110 feet below the surface at Toronto, but is the uppermost limestone in this well. I desire in the future to locate the outcropping of the remaining strata of the Madison well along the Verdigris river, and prepare a section along the Verdigris from the state line, showing the wells at Neodesha, Fredonia, Fall River, Toronto, and Madison.

I have put up samples of the various strata to be deposited with the Kansas Academy of Science for preservation.

ON THE CORRELATION OF THE COAL MEASURES OF KANSAS AND NEBRASKA.

BY J. W. BEEDE, LAWRENCE.

Read before the Academy December 29, 1898.

Since the appearance of Meek and Hayden's Final Report of the United States Geological Survey of Nebraska in 1872, owing to the thoroughness of discussion and the care in the descriptions and figures of a large number of typical Upper Coal Measures fossils, it has become the basis for the identification of fossils of this formation of the West. On account of this fact and the great care with which the stratigraphy of the Missouri river bluffs in Nebraska was worked out, it is of great stratigraphic importance as well, forming, as it were, the type section of the Upper Coal Measures strata of the Missouri valley, leaving only the limitations to be worked out by later geologists.

Professor Prosser gives an admirable review of the history of the geology of Otoe county in the January number of the *Journal of Geology* for 1897, to

* Univ. Geol. Survey, vol. I, p. 143.

† Record of C. L. Bloom, driller.

which the reader is referred for the history and bibliography of the subject. This history is, in brief, as follows: Owen in 1852, and Swallow in 1855, referred the strata at Nebraska City, Neb., to the Upper Carboniferous; the latter to the "Upper Coal Series." Marcou in 1855 published a geological map of the United States in which these rocks were referred to the Triassic. In 1857 Hayden published a map representing them as Carboniferous. In 1864 Marcou published sections of these rocks referring them to the Permian, and the next year Meek criticizes him and refers them to the Upper Coal Measures. In 1866 Geinitz concludes with Marcou that they are Permian. In 1872 Meek published his Final Report, concluding that the rocks belonged to the Upper Coal Measures, and all later work has corroborated him in this opinion.

After an extended study of the Permian and Coal Measures in Kansas, Professor Prosser, in the article referred to, gives the results of his observations on the rocks of eastern Nebraska, based on their relation to the Cottonwood limestone above. He thinks that the rocks at Nebraska City belong to either the lower portion of the Wabaunsee formation or the upper part of the underlying formation, for he says that "Meek found *Spirifer cameratus* in the limestone above the coal, associated with plenty of other fossils characteristic of the Upper Coal Measures, and that it is clearly shown by the stratigraphy and paleontology that all the Paleozoic rocks in the vicinity of Nebraska City belong to the Upper Coal Measures (Missourian) instead of the Dyas (Permian), as claimed by Marcou. The writer is not confident whether the Nebraska City beds should be referred to the upper part of the Missouri formation or to the Wabaunsee formation of the Missourian series. However, the faunal and lithologic characters of these beds agree quite closely with those of the lower half of the Wabaunsee formation as shown along the Kansas river above Topeka, and so the writer refers them provisionally to it" (page 20, reprint). Also, on page 18 (reprint), speaking of the shales used for vitrified bricks at the Nebraska City works, occupying the position of Meek's original section, he remarks that these "shales are mostly of a drab color, somewhat micaceous as well as clayey, and resemble those used for vitrified bricks at the Topeka, Kan., works." He also studied the rocks of the bluffs on the west side of the Missouri as far as the Platte river, where the Paleozoic is covered by the Cretaceous. He says: "On the Platte river [near Louisville] the Permian is not represented and the Dakota sandstone rests unconformably on the limestones and shales of the Wabaunsee formation. This is, consequently, a very important section, as it shows that the 800 feet of Permian rocks exposed along the Kansas and Smoky Hill rivers in Kansas have disappeared and the Dakota sandstone of the Cretaceous system rests on the Wabaunsee formation of the Missourian series of the Upper Carboniferous. This conclusion agrees with that of Doctor Hayden, who on his geological map of Nebraska in 1858 represented the Lower Cretaceous (now known as the Dakota sandstone) on the Platte river as resting on the Carboniferous."

While Prosser finds the Cretaceous resting on the Wabaunsee formation on the Platte, yet he finds the Cottonwood formation four miles west of Auburn, Neb., at an elevation of about 345 feet above the Missouri river, and the base of the Permian is probably found in Gage county; and Knerr recognizes over 200 feet of Permian in Marshall county, Kansas * (adjoining Gage county, Nebraska, on the south).

The works of Meek and Prosser agree very well. Meek positively locates the rocks along the lower part of the Missouri river in Nebraska in the Upper Coal Measures. Prosser also locates them in the Upper Coal Measures and provision-

* Univ. Geol. Surv. Kans., vol. I, p. 144.

ally places them (those at Nebraska City) in the lower half of his Wabaunsee formation, basing this correlation on the nature and fauna of the rocks and their relation to the Cottonwood formation above.

It is my purpose to give a few observations on their stratigraphic relations to their supposed equivalents along the Kansas river in Kansas, and to trace some of the latter until they practically connect with the rocks studied by Meek and Hayden.

THE NEBRASKA CITY SECTION.

PROSSER'S SECTION.

The Nebraska City section, as it now appears at the brick-yards diggings, near the old landing, is accurately given by Professor Prosser in the article referred to (page 19, reprint). I quote it here, as my section adds no new features of importance:

	ft.	Thickness.		ft.	in.
		in.	ft.		
"8. Massive somewhat calcareous sandstone	2	6	40	6	
7. Rather arenaceous shales	15	0	38	0	
6. Limestone with fossils, <i>Fusulina cylindrica</i> , etc. (No. 3 of Meek's section)	1	1	23	0	
5. Black, very bituminous shales with thin layers of coal (No. 2 of Meek's section)	1	11	21	11	
4. Mainly argillaceous shales	9	0	20	0	
3. Arenaceous shales with thin, irregular sandstone at top ..	5	0	11	0	
2. Massive, soft and friable brownish sandstone (about railroad level); Nos. 2 and 3 equal division D of Meek's section	3	0	6	0	
1. Argillaceous shales that furnish material for vitrified bricks (the upper part of division C of Meek)	3	0	*3	0**	

No. 8 is quite fossiliferous, as may be seen on the weathered edges, containing pelecypods and gastropods, though they do not weather out satisfactorily, nor can they be separated from the matrix. No. 6 sometimes attains a thickness of two feet. From the base of this section to within thirteen feet of the river at low-water level the rocks are covered. About thirteen feet above low-water mark there is a light gray massive limestone, exposed in two layers of about nine inches each, beneath which are about three feet of light green, argillaceous shales resting on some red shales. The remainder of the section is covered.

Owing to the changed condition of the section at Nebraska City, and the ease of comparing the full section with the sections and their fauna of the Kansas Coal Measures, it is necessary to give here Meek's section and the fossils collected from it:

MEEK'S SECTION.

	Thickness.	
	ft.	in.
"Loess or bluff deposit, consisting of fine, light grayish pulverulent siliceous and more or less calcareous clay or marl, without distinct marks of stratification; rising back to the height of 80 to	90	0
D. Yellowish-gray micaceous soft sandstone, laminated or in thin, ripple-marked layers, excepting 12 to 15 inches of the lower part, which is sometimes hardened and compact; with fragments of plants ..	10	0
C. Drab, ash, and lead-colored, and reddish-brown clays, with, near the middle, a 9- or 10-inch hard bluish-gray argillaceous layer, weathering to a rusty color. Fossils numerous, particularly near the lower part, as follows: <i>Rhombopora lepidodendroides</i> , <i>Lophophyllum proliferum</i> , <i>Scaphiocrinus</i> ?, <i>hemisphaericus</i> , <i>Eocidaris Hallianus</i> , <i>Synocladia biserialis</i> , <i>Fenestella Shumardi</i> , <i>Polypora submarginata</i> , <i>Glaucanome trilineata</i> , <i>Lingula Scotica</i> ?, <i>Hemipronites crassus</i> , <i>Syntrielasma hemiplicata</i> , <i>Chonetes glabra</i> , <i>C. granulifera</i> , <i>Productus pertenuis</i> , <i>Productus longispinus</i> (?), <i>P.</i>		

* In the above section, in the original, the total thickness is calculated without No. 1. I have taken the liberty to change the second column of figures so as to include No. 1, making the section 40 feet 6 inches, instead of 37 feet 6 inches.

	Thickness. ft. in.	
Prattenianus, P. Nebrascensis, P. symmetricus, P. semireticulatus, Rhynconella Osagensis, Spirifer cameratus, Spirifer (Martinia) planoconvexus, Spiriferina Kentuckensis, Athyris subtilita, Lima retifera, Entolium aviculatum, Aviculopecten carbonarius, A. neglectus, A. coxanus, A. occidentalis, Myalina Swalovi, M. subquadrata, Avicula longa, Avicula (?) sulcata, Aviculopinna Americana, Pseudomonotis radialis (?), Nucula Beyrichi (?), Nucula ventricosa, Yoldia subscitula, Nuculana bellistriata, Macrodont tenuistriata, Solenomya sp., Modiola subelliptica, Edmondia reflexa, Solenopsis solenoides, Pleurophorus oblongus, Schizodus curtus, S. Wheeleri, Schizodus sp., Edmondia Nebrascensis, E. (?) glabra, Prothyris subelegans, Allorisma (Sedgwickia) subelegans, A. (S.) Geinitzi, A. reflexa, Dentalium Meekianum, Bellerophon Montfortianus, B. percarinatus, B. Marcouanus, B. carbonaria, Euomphalus rugosus, Orthonema subtaeniata, Aclis Swallowiana, Pleurotomaria Haydeni, P. subdecussata, P. Marcouana, P. Grayvillensis, Orthoceras cribrorum, Nautilus occidentalis, Cythere Nebrascensis, and Cythere sp.		
B. Several beds of hard, light grayish and yellowish limestones, in layers from five to twenty inches in thickness, with soft, marly clay seams and partings. Fossils: Fusulina cylindrica, Rhombopora lepidodendroides, Lophophyllum proliferum, Erisocrinus typus, Syncnadia biserialis, Hemipronites crassus, Orthis carbonaria, Meekella striatocostata, Syntrielasma hemiplicata, Chonetes granulifera, Chonetes glabra, Productus longispinus (?), P. semireticulatus, P. costatus, P. Prattenianus, P. Nebrascensis, P. symmetricus, Rhynconella Osagensis, Spirifer (Martinia) planoconvexus, S. cameratus, Athyris subtilita, Retzia punctulifera, Pinna peracuta, Myalina subquadrata, Allorisma subcuneata, Euomphalus rugosus, Bellerophon carbonaria, Phillipsia scitula, Cladodus mortifer, and Deltodus? angularis.....	51	0
A. a. Lead grayish and greenish clay, 4 feet.		
b. Reddish-brown, ferruginous, slightly gritty, indurated clay, 4 feet exposed above high-water mark	8	0
Total below drift.....	69	0"

The section at Otoe (now Minersville) seems to be very much like what it was when Meek was there. As my time here was too limited to make a carefully detailed section, that of Meek is here given.

MEEK'S OTOE SECTION.	Thickness. ft. in.	
"Loess, with some drift at the base	40	0
11. Soft, yellowish sandstone	10	0
10. Drab and ash-colored, with seams and concretions of arenaceous matter	3	0
9. Bluish laminated clays, passing gradually into the next below	7	0
8. Nearly black laminated clay or shale, with sometimes between it and the bed above a 6- or 8-inch bed of yellow limestone in the shale. Productus Prattenianus, P. longispinus (?), Sp. (Martinia) planoconvexus, Rhynconella Osagensis, Chonetes granulifera, Spiriferina Kentuckensis, Productus semireticulatus, Hemipronites crassus	3	0
7. Very hard, dark-gray calcareous layer	0	4
6. Red, green, blue, and light ash-colored clays, with near the base a 2- or 3 inch seam of black shale	58	0
5. Soft, drab, marly material, becoming in parts hard and compact, or with hard calcareous seams. Millions of Fusulina cylindrica; also, Chonetes granulifera, Hemipronites crassus, Spirifer cameratus, Spiriferina Kentuckensis, Syntrielasma hemiplicata, Meekella striatocostata, Productus semireticulatus, Myalina perattenuata.....	3	0

MEEK'S OTOE SECTION—*continued*.

	Thickness.	
	ft.	in.
4. Light drab laminated clay, with streak of black; at one place seen to swell out so as to form a bunch of coal 6 to 8 inches thick, with efflorescence of iron sulphate	1	6
3. Soft, incoherent yellowish sandstone	6	0
2. Soft, bluish, sandy shale, with large, round, and compressed oval concretions	5	0
1. Bluish and drab clays, in parts more or less arenaceous. Productus Prattenianus	15	0
Total, exclusive of loess and drift	111	10

MEEK'S SECTION TWO MILES ABOVE RULO,
ON THE MISSOURI.

	Thickness.	
	ft.	in.
"7. Loess, with perhaps some drift, 70 to	80	0
6. Massive yellow limestone	5	0
5. Gray and yellowish impure limestone and drab clays	4	6
4. Bluish and drab arenaceous clay with fossil ferns. Neuropteris hirsuta and N. Loschii	7	0
3. Coal	0	6
2. Indurated clay, called soapstone by the miners. (Not seen)	0	4
1. Bluish laminated sandstone, very soft, with streaks of black, and looking very much like No. 1 in the Brownville section	8	0

"The whole of this exposure seemed to me to have bodily slipped a little below its true horizon, probably by the washing away of the soft sandstone beneath by the river. This appearance is also affirmed by the statements of the miners, who informed me that the coal ended and that all the beds change abruptly at the end of the drift, forty or fifty feet in. The thickness, composition and order of succession of the beds, however, can be very clearly seen."

SHAFT AND BORING ONE AND ONE-HALF MILES SOUTH
OF RULO. MEEK.

	Thickness.	
	ft.	in.
"1. Yellow indurated clay, called soapstone by the miners	18	0
2. Yellow limestone	3	0
3. Blue clay. In this clay, lying near the shaft, we have found the following fossils: Rhombopora lepidodendroides, an encrusting species of Fistulipora; Polypora submarginata, Hemipronites crassus, Productus Nebrascensis, P. Prattenianus, Chonetes granulifera, Syntrielasma hemiplicata, Spirifer (Martinia) planoconvexus, Sp. cameratus, Nucula (?) sp., Pleurotomaria perhumerosa, and several undetermined species of Murchisonia	12	0
4. Hard, gray limestone	11	0
5. Blue clay	17	0
6. Limestone	3	0
7. Blue clay bored into below the limestone	12	0
Total	76	0

"At the mouth of the Great Nemaha, a mile or two farther down the Missouri, Doctor Hayden saw an exposure (the same mentioned by Doctor Owen) of soft sandstone rising twenty or thirty feet above the river, with above it a thin (five- or six-inch) seam of coal connected with arenaceous shales, containing the same ferns found over the bed of coal two miles above Rulo and at Brownville.

"The elevation of this coal and sandstone here above the Missouri shows that there is quite a perceptible rising of the strata in this direction, the same coal being only about eight feet above the river two miles above Rulo, though it had apparently slid somewhat below its true horizon at the latter place. I am inclined to believe that this sandstone under the coal is the same bed seen at Peru and Brownville and at the base of the section at Aspinwall, though it may be another holding a lower position. If it is the same, there can be little doubt but the exposures here near Rulo hold a position in the series above the horizon at the Nebraska City section. On these points, however, more detailed examination than we had an opportunity to make are desirable."

While at Nebraska City and Otoe (Minersville) the greater part of my time was devoted to collecting. Most of Meek's division C is covered by the railroad, though the upper part is well exposed, as is also division D. Prosser has shown

the carbonaceous shale and argillaceous limestone, mentioned by Meek as exposed south of the section, to be present at the exposure at the brick-yards.

Following is a list of the specimens secured at Nebraska City in a day and a half of collecting. The list is provisional.

- Fusulina secalica* (Say) * = *Fusulina cylindrica* Fischer, aa †.
Lophophyllum proliferum (McChesney) Meek, c.
Rhombopora lepidodendroides Meek, rr.
 Bryozoa, rr.
Meekella striatocostata (Cox) White and St. John, a.
Productus longispinus Sowerby ?, a.
Productus costatus Sowerby, r.
Productus semireticulatus Martin, a.
Productus punctatus Martin, r.
Productus cora d'Orbigny, aa.
Productus pertenuis Meek, r.
Enteletes hemiplicatus (Hall) Hall and Clarke = *Syntrielasma hemiplicata*, r.
Chonetes granulifera Owen, aa.
Chonetes glabra Geinitz, a.
Hustedia mormoni (Marcou) Hall and Clarke = *Retzia punctulifera* and *R. mormoni*, rr.
Derbya robusta (Hall) Waagen ?, rr.
Derbya crassa (Phillips) Hall and Clarke = *Hemipronites crassus*, rr.
Spirifer cameratus (Hall) Meek, c.
Ambocoelia planoconvexa (Shumard) Hall and Clarke = *Spirifer* (*Martinia*) *planoconvexus*, a.
Seminula argentea (Shepard) Hall and Clarke = *Athyris subtilita*, a.
Spiriferina cristata (Schlotheim) Davidson = *S. kentuckensis*, r.
Chonetes verneuilliana Norwood and Pratten?, rr.
Orbiculoidea sp. = *Discina*, rr.
Pugnax utah (Marcou) Hall and Clarke = *Terebratula* and *Rhynchonella osagensis*, aa.
Chænomya sp., rr.
Aviculopecten sp., rr.
Aviculopecten occidentalis Shumard, rr.
Monopteria marian White?, rr.
Schizodus sp., rr.
Schizodus wheeleri Swallow, aa.
Schizodus curtus Meek and Worthen, a.
Allorisma costata Meek and Worthen, rr.
Allorisma subcuneata Meek and Hayden, c.
Allorisma granosa (Shumard) Meek, rr.
Allorisma reflexa Meek?, rr.
Entolium aviculatum (Swallow) Meek, c.
Modiola? *subelliptica* Meek, rr.
Pinna peracuta Shumard, rr.
Pseudomonotis, rr.
Myalina subquadrata Shumard, rr.
Edmondia, 2 species, rr.

* Through the kindness of Prof. Stuart Weller, of Chicago, I was informed that our *Fusulina cylindrica*, described by Fischer in 1837, was described by Say, under the name of *Miliolites secalicus*, from near the Platte river on the Missouri river, in Nebraska, in Long's Expedition, published in 1823, p. 151, foot-note. As it is impossible to confound it with any other species in the region, it gives the specific name *secalica* (Say) priority.

† r=rare, rr=very rare, c=common, a=abundant, aa=very abundant.

Nucula beyrichii ?? Schaubroth, rr.
Macrodon sp., rr.
Lima retifera Shumard, rr.
Bellerophon carbonaria Cox, rr.
Bellerophon marcouana Geinitz, rr.
Bellerophon montfortianus Norwood and Pratten, rr.
Bellerophon ? cast, rr.
Pleurotomaria sp., rr.
Pleurotomaria subdecussata Geinitz, rr.
Murchisonia sp., rr.
Aclis sp., rr.
Straparollus (*Euomphalus*) *subrugosus* Meek, rr.
Loxonema rugosa Meek and Worthen, rr.
Small slender gastropod, rr.
Dentalium meekianum Geinitz, rr.
Cythere sp., a.
Phillipsia scitula Meek and Worthen, rr.
Nautilus forbesianus McChesney ??, rr.
Several undetermined species of Mollusca and a fish tooth.
The following were collected at the Minersville section :
Fusulina secalica (Say) Fischer, aa.
Rhombopora lepidodendroides (McChesney) Meek, c.
Bryozoa, 3 species, rr.
Productus cora d'Orbigny, c.
Productus semireticulatus Martin, rr.
Productus costatus Sowerby, rr.
Productus nebrascensis Owen, rr.
Productus pertenuis Meek, a.
Derbya crassa (Phillips) Hall and Clarke, a.
Spirifer cameratus (Hall) Meek, r.
Spiriferina cristata (Schlotheim) Davidson, rr.
Meekella striatocostata (Cox) White and St. John, rr.
Chonetes glabra Geinitz, r.
Chonetes granulifera Owen, aa.
Ambocoelia planoconvexa (Shumard) Hall and Clarke, a.
Myalina perattenuata Meek and Worthen, rr.
Allorisma sp., rr.
Nucula ventricosa Hall ?, rr.
Zeacrinus ? *mucrospinus* McChesney, rr.

In collecting the fossils mentioned in these two lists no attempt was made to keep those of the different strata or groups of strata separate, except the two localities, as the matrix from which they were taken had been removed from its original position and mingled to a greater or less extent. Some of the species in the above list are not mentioned by Meek, while others that he found were not to be had at this time on account of the covering of the rocks that contained them.

During the past summer the Burlingame limestone of the Wabaunsee formation was traced from the Kansas river just west of Topeka, Kan., to the Nebraska line, where it seems to connect with Meek's southern sections of the Missouri river bluffs. This seemed to be an additional evidence of the close relation of the Coal Measures of eastern Nebraska and Kansas, and led to a more close comparison of the rocks and fauna.

TOPEKA SECTION.

A general section of the rocks of Topeka, Kan., with their fossils is given in the preceding volume of these Transactions (page 27). The parts of the section here given are from the Topeka limestone to the Burlingame limestone, inclusive, in a more detailed manner and with the fossils grouped for comparison with the Nebraska City section. The Topeka limestone is exposed in the Shawnee county quarry, at the fair-grounds in the southern limits of the city; also a mile and a half southeast; and at Calhoun bluffs, three miles northeast of Topeka.

Bennett's description of the beds is the best that has yet appeared, and is here given in full: *

"In an exposure a mile east and a mile south of Topeka there is a showing of the upper section of the underlying shales. About six and one-half feet below the top of the underlying shales a fairly good building sandstone is reached, which is three feet thick. The lower limestone of the Topeka system is six feet thick, and is blue, but weathers dark buff. Above it is a foot and a half of blue shale, then above that five feet eight inches of blue and brown limestone, having a cherty layer near the top. Above this comes two feet of buff shale, and then again limestone one and one-half feet thick, above which are three feet of drab shales, which are again capped by two feet of limestone."

Bennett gives the following list of fossils as collected in this limestone: *Fusulina cylindrica*, *Chaetetes* and a ramous form of *Chaetetes*, *Archæocidaris* —, *Zeacrinus mucrospinus* and *Zeacrinus acanthropus*, *Fenestella* —, *Chonetes granulifera*, *Productus punctatus*, *Productus longispinus*, *Productus costatus*, *Productus prattenianus*, *Athyris subtilita*, *Spirifer cameratus*, *Streptorhynchus crassus*, *Terebratula bovidens*, *Retzia mormoni*, *Bellerophon carbonarius*.

I have collected the following fossils from these limestone beds:

Fusulina secalica (Say) Fischer, aa.

Lophophyllum proliferum (McChesney) Meek, r.

Archæocidaris agassizi Owen ?, plates and spines, a.

Rhombopora lepidodendroides Meek, c.

Septopora biserialis (Swallow) Ulrich = *Synocladia biserialis*, r., and about ten other species which seem to be of the genera *Fenestella*, *Polypora*, *Streblopora*, *Stenopopora*, and *Blatostomella*.

Productus cora d'Orbigny, aa.

Productus costatus Sowerby, c.

Productus longispinus Sowerby ?, aa.

Productus nebrascensis Owen, aa.

Productus punctatus Martin, c.

Productus semireticulatus Martin, c.

Productus pertenuis Meek, c.

Chonetes granulifera Owen, aa.

Spirifer cameratus (Hall) Meek, aa.

Reticularia perplexa (McChesney) Schuchert = *Spirifer* (Martinia) *lineata*, rr.

Ambocelia planoconvexa (Shumard) Hall and Clarke, r.

Spiriferina cristata (Schlotheim) Davidson, rr.

Orbiculoidea missouriensis (Shumard) Schuchert = *Discina nitida*, rr.

Seminula argentea (Shepard) Hall and Clarke, aa.

Hustedia mormoni (Marcou) Hall and Clarke, r.

Derbya crassa (Phillips) Hall and Clarke, c.

Derbya robusta (Hall) Waagen, r.

Dielasma bovidens (Morton) White = *Terebratula bovidens*, r.

*Univ. Geol. Surv. Kan., vol. I., p. 117.

Myalina swallovi McChesney, r.
Allorisma granosa (Shumard) Meek, r.
Allorisma subcuneata Meek and Hayden, rr.
Allorisma sp., rr.
Monopteria marian White, rr.
Aviculopecten winchelli Meek ??, rr.
Aviculopecten sp., rr.
Entolium aviculatum (Swallow) Meek, c.
Schizodus curtus Meek and Worthen, c.
Schizodus rossicus DeVerne ?, rr.
Pinna peracuta Shumard, r.
Macrodon tenuistriatus Meek and Worthen, rr.
Macrodon sp., rr.
Cf. Murchisonia marcouana Geinitz, rr.
Aclis swallovia Meek, rr.
Bellerophon carbonarius Cox, rr.
Orthoceras sp., rr.
Phillipsia major Shumard ?, rr.
Phillipsia scitula Meek and Worthen, rr.
Peripristis semicircularis Meek and Worthen, rr.
Petalodus destructor Newberry and Worthen, rr.

Crinoids are occasionally found in this limestone, but generally too poorly preserved to admit of determination.

Overlying the Topeka limestone is a series of shales and sandstones. The only good exposure of this series near Topeka is at the Topeka vitrified brick works, three miles west of the city, where twenty-four feet of them are exposed. The lower portion of this exposure is a soft concretionary sandstone, somewhat micaceous, over which lie fifteen feet of shales, the lower portion of which is arenaceous and sometimes contains plant remains, while the upper part is bluish and argillaceous. Over these are a few feet of yellowish shales, overlaid by the Topeka-Osage coal, which varies from ten to sixteen inches in thickness. North of the Kilmer siding (about ten miles northeast of Topeka) the Topeka limestone and coal can both be located on the east slope of the hill on the east and west road. This, taken in connection with the section about a half-mile north of where the road crosses a little tributary to the Big Muddy, makes the following section:

	Thickness.		Total.	
	ft.	in.	ft.	in.
7. Covered slope, several feet.				
6. Rotten clayey limestone	1	8	74	6
5. Olive to brownish shale	4	0	72	10
4. Olive and brownish shales	10	0	68	10
3. Hard, black, arenaceous shales and coal		10	58	10
2. Shales	55	0	58	0
1. Topeka limestone exposed in the bed of the creek, of the same characteristic appearance and fossils as near Topeka	3	0	3	0

Next above these shales, overlying the Topeka limestone, is the Osage coal. This coal is not in one continuous layer, but in a series of beds of considerable extent lying in one remarkably uniform horizon, varying but few feet vertically in many miles. The Topeka bed is probably best developed along a line from a point four miles west of Topeka in a southeasterly direction to the Capital coal-mine, three miles nearly south of Topeka. The average thickness is about, or a little over, a foot in this part of the bed.

Above the coal lie the Shunganunga shales, which at the Capital coal-mine

are about two feet thick, varying from a blue to deep black in color, and are very fossiliferous, while at Carbondale they are fourteen feet thick. Above these shales and grading into them lies what Swallow called the "Spring Rock" (wrongly correlating it, as he did also the "Stanton limestone," now known as the Burlingame limestone, with limestones of eastern Kansas—the names were used by the writer in the previous article on this section), a hard, bluish, argillaceous limestone of from one and one-half to two feet in thickness, which has been used in paving with good results. These three strata are well exposed in the pits of the vitrified brick works, and from there west to the Sargent brick works, east of the sugar-mill. At this latter place sixty feet of the overlying strata are exposed. The section as made up of this long but continuous exposure is as follows:

	Ft.	In.	Ft.	In.
6. Argillaceous shale, arenaceous in places, olive to blue in color, and in the upper part yellow.....	50	0	61	6
5. Blue, impure, argillaceous limestone	1	0	11	6
4. Blue, yellow or olive, argillaceous, in places arenaceous shales, varying in thickness from 2 to.....	6	0	10	6
3. Argillaceous blue limestone, weathering to a rusty color	1	6	4	6
2. Argillaceous, bluish to black shale, very fossiliferous	2	0	3	0
1. Coal.....	1	0	1	0

Near the bottom of No. 4 there is generally an impure limestone which, at the Sargent brick works, is a foot thick, as shown in the bed of the creek.

In order to avoid long repetition, the fossils of all these strata, except No. 6, are given in one list. They belong principally to Nos. 2 and 3, with a few in 4 and 5.

Fusulina secalica (Say) Fischer, a.

Archæocidaris agassizi Geinitz, rr.

Campophyllum torquium Owen, rr.

Delicrinus hemisphæricus, rr.

Rhombopora lepidodendroides Meek, c.

Septopora biserialis (Swallow) Ulrich, r., and other bryozoa as in the previous list.

Productus longispinus Sowerby, aa.

Productus cora d'Orbigny, c.

Productus costatus Sowerby, c.

Productus Nebrascensis Owen, r.

Productus punctatus Martin, r.

Productus semireticulatus Martin, a.

Productus symmetricus McChesney, r.

Productus pertenuis Meek, a.

Productus sp., r.

Chonetes granulifera Owen, aa.

Chonetes glabra Geinitz, c.

Spirifer cameratus (Hall) Meek, aa.

Ambocelia planoconvexa (Shumard) Hall and Clarke, aa.

Spiriferina cristata (Schlotheim) Davidson, a.

Pugnax utah (Marcou) Hall and Clarke, c.

Orbiculoidea missouriensis (Shumard) Schuchert, aa.

Orbiculoidea convexa (Shumard) Schuchert, rr.

Lingula mytiloides Sowerby, c.

Seminula argentea (Shepard) Hall and Clarke, aa.

Hustedia mormoni (Marcou) Hall and Clarke, c.

Derbya crassa (Phillips) Hall and Clarke, c.

- Derbya robusta* (Hall) Waagen ?, r.
Dielasma bovidens (Morton) White, r.
Enteletes hemiplicatus (?) Hall, c.
Myalina? sp., rr.
Myalina perattenuata Meek and Hayden, c.
Myalina swallovi McChesney, c.
Allorisma granosa Meek, r.
Allorisma subcuneata Meek and Hayden, rr.
Allorisma topekaensis Swallow, rr.
Monopteria marian White, rr.
Monopteria gibbosa Meek and Worthen, rr.
Aviculopecten coxanus Meek and Worthen, rr.
Aviculopecten carboniferus Stevens, r.
Aviculopecten hertzeri Meek, rr.
Aviculopecten cf. *lyelli* Dawson, rr.
Aviculopecten maccoyi Meek and Hayden, rr.
Aviculopecten neglectus Geinitz, rr.
Aviculopecten occidentalis Shumard, c.
Aviculopecten rectilaterarius Cox ?, a.
Nuculana bellistriata Stevens, r.
Nuculana bellistriata attenuata Meek, r.
Modiola subbelliptica Meek, c.
Solenomya radiata Meek and Worthen, r.
Entolium aviculatum (Shumard) Meek, c.
Schizodus curtus Meek and Worthen, r.
Schizodus curtiformis Walcott?, r.
Schizodus sp., rr.
Avicula longa Geinitz, rr.
Lima retifera Shumard, r.
Nucula ventricosa Hall, rr.
Pinna peracuta Shumard, rr.
Macrodon tenuistriatus Meek and Worthen, rr.
Prothyris elegans Meek, rr.
Aviculopinna americana Meek, rr.
Macrocheilus anguliferus White, rr.
Macrocheilus ventricosus Meek, r.
Macrocheilus primigenius (Conrad) Hall, rr.
Loxonema sp., rr.
Euomphalus (*Straparollus*) *subrugosus* Hall, c.
Anomphalus rotulus Meek and Worthen?, rr.
Bellerophon bellus Keyes, c.
Bellerophon percarinatus Conrad, rr.
Bellerophon carbonarius Cox, rr.
Bellerophon sp., rr.
Orthonema subtaeniata Geinitz, rr.
Naticopsis nana Meek and Worthen, r.
Naticopsis ventricosus (Norwood and Pratten) Meek and Worthen, r.
Naticopsis altonensis McChesney?, r.
Pleurotomaria grayvillensis Norwood and Pratten?, rr.
Pleurotomaria illinoiensis Worthen?, rr.
Pleurotomaria perhumerosa Meek, r.
Pleurotomaria sphærulata Conrad?, r.

Pleurotomaria subdecussata Geinitz, rr.
Pleurotomaria tabulata Hall, rr.
Nautilus occidentalis Swallow?, rr.
Nautilus ponderosus White??. rr.
Nautilus cf. *planovolvis* Shumard, rr.
Orthoceras cribrosum Geinitz, r.
Phillipsia scitula Meek and Worthen, c.
Peripristis semicircularis Newberry and Worthen, rr.
Petalodus destructor Newberry and Worthen, rr.

The lower portion of the Burlingame shales has already been described as No. 6 of the preceding section. The upper portion of them is well exposed along the west bank of Mission creek and on the point of the hill between Mission and Blacksmith creeks a few rods south of their junction. In the latter place, on both sides of the point, about fifteen feet of olive, argillaceous shales are exposed, with occasional laminæ of more calcareous shales which are largely composed of fossils, mostly pelecypods and bellerophons, with, in one place, myriads of ostracod crustaceans. Near the upper part of the exposure, on the east side of the point, may be seen a thin layer of coal, some distance above which is a heavy limestone (farther south on the hill). At present I know of no place where these shales are all well exposed, but in various covered slopes there are many indications that in places these shales are quite arenaceous and even contain sandstone. They are 120 feet thick at the sugar works, six miles west of Topeka. Resting on this shale bed at the sugar works is a thin bed of coal, the same mentioned at the junction of Mission and Blacksmith creeks, the Silver Lake coal, and above the coal is a foot of argillaceous limestone. Along the Kansas river this limestone is somewhat continuous, but farther south near the head of Blacksmith creek it is, in one place, but a series of large, round, concretion-like forms, while at another place near there it is wanting. Overlying this limestone are shales which are moderately fossiliferous, fifteen to thirty feet in thickness, well exposed near the tops of the bluffs just west of the sugar works. They are yellow to olive in color and argillaceous.

Upon these shales rests the Burlingame limestone. This limestone is composed of four strata. The lowermost is, on the average, about five feet or a little more in thickness. Immediately above this, and separated from it by a thin parting of yellow calcareous clay, is another stratum of limestone of the same general appearance, but thinner. Both are massive, sparsely fossiliferous, and weather to a buff tint. Some distance above the second limestone, but seldom well exposed, are two small limestones separated by a parting of shale.

The fauna of the Burlingame shales and the other strata up to, and including the Burlingame limestone, is:

Fusulina secatica (Say) Fischer, aa.
Productus nebrascensis Owen, r.
Lingula mytiloides Sowerby, c.
Chonetes granulifera Owen, r.
Hustedia mormoni (Marcou) Hall and Clarke, r.
Myalina sp., rr.
Myalina swallovi McChesney, c.
Modiola subelliptica Meek, r.
Nuculana bellistriata Stevens, r.
Nuculana bellistriata attenuata Meek, rr.
Aviculopecten rectilaterarius Cox, r.
Aviculopecten occidentalis Shumard, r.

Allorisma granosa (Shumard) Meek, rr.
Allorisma topekaensis Swallow, c.
Schizodus curtus Meek and Worthen, rr.
Nucula ventricosa Hall, rr.
Pinna peracuta Shumard, rr.
Bellerophon sp., rr.
Euomphalus (*Straparollus*) *subrugosus* Hall, r.
Bellerophon carbonarius Cox, r.
Pleurotomaria subdecussata Geinitz, rr.
Nautilus occidentalis Swallow ?, rr.
Cythere sp., aa.

The general direction of the escarpment of the Burlingame limestone is northeast from Martin's hill, five miles west of Topeka, to near Meriden, where it turns north for about ten miles, to the latitude of Valley Falls. At Cedar Falls, two and a half miles west and a little north of Valley Falls, the Burlingame limestone caps the bluff. One hundred and twenty feet below the limestone (barometric measurement) the second limestone above the Osage coal appears in the bed of the creek, forming the falls, which are about four feet high. Nearly beneath the bridge the water runs over what appears to be the cap rock of the Osage coal, five or six feet below the falls. The Osage coal is mined just southeast of the bridge, about half a mile, and also northeast of Valley Falls, on the east side of the Delaware river. The base of the dam at Valley Falls is said to be on a limestone, which is probably one of the upper members of the Topeka system. By barometric measurement, it is fifty-five feet below the coal mentioned near Cedar Falls.

The Burlingame limestone appears east of the Delaware river near Valley Falls, in the divide between the heads of Spring, Crooked, and Walnut creeks, upon which the town of Winchester is situated. From here its most eastern extension passes nearly due north to the Nebraska line, bending to the westward before entering the valley of the Great Nemaha river, and passing out of the state.

After passing north from Larkin the escarpment becomes invisible and the exposures very meager and rare. In addition to this, the lower member of the limestone, if I am not mistaken, separates from those above by the thickening of the shale between and changes somewhat in appearance, becoming more of a buff color and *Fusulina secalica* becomes abundant. There is a quarry of this lower stratum just east of the Horton water-works, and on the road running east from the center of the city it is exposed in the ravines between there and Everest, and probably extends along the Everest divide for six or seven miles to the east of that place, and then falls back west of Robinson in crossing Wolf river. Coming back on the north side of Wolf river, it is in the hill north of Robinson at the Robinson schoolhouse and is quarried in several places near there. One of the best exposures of this neighborhood is seen three miles to the northeast on the side of the road, in a ravine running south. There is quite a quarry situated there, and beneath and south of the quarry on the west side of the ravine is an exposure of about fifteen feet of olive, blue and black shales, including a thin stratum of limestone, which is composed for the most part of fossil mushroom-shaped organisms of considerable size. Beneath these there is a foot or more of impure limestone.

Coal has been mined at Robinson, in the creek bed. It is considerably below the limestone at the schoolhouse. The upper part of the exposure at the creek is composed of sandy shales and crumbly sandstone, beneath which the coal lies generally hidden.

The coal-mines of the northeastern part of the state are a great aid in the study of the stratigraphy. After passing north from Valley Falls it seems to be the Silver Lake coal that is mined. Mines are or have been located "five miles southwest of Horton" (I was unable to verify this statement, but it was probably on Cedar creek), about five miles southwest of Severance, at Robinson, on Roys creek about eight miles west of White Cloud, and on the north side of the Nemaha river in Nebraska nearly due north of Robinson, Kan., and near Rulo, Neb.

I think all the above mentioned mines are in the horizon of the Silver Lake coal, though it is possible that it is that of the Osage coal, and the limestone here considered as the base of the Burlingame system is the same as the cap-rock to the Osage coal. I did not have the opportunity to settle this point completely. On the north side of the road, three miles west of Hiawatha, on a little southern branch of Walnut creek, is a quarry of limestone, the elevation of which is a trifle over 1000 feet A. T., or about the same as the quarry mentioned near Robinson, which is almost ten miles east of this. Considering the fact that the strata are almost level here (probably dipping a little to the west), one would expect this western quarry to be stratigraphically somewhere from twenty to fifty feet above that at Robinson. The nature of the rock in the Hiawatha quarry is almost exactly the same as that of the Wakarusa limestone, which is fifteen to forty feet above the Burlingame limestone near Topeka. It is literally a mass of shells crushed together, forming a solid limestone two or three feet thick. With this check on the tracing, I think it safe to correlate, provisionally, the Robinson limestone with the Burlingame.

On Roys creek and its tributaries, eight to ten miles north of Robinson, are some fairly good exposures showing the same sections as at Robinson. The lower member of the Burlingame limestone is exposed near the base of the bluff on the north side of the Great Nemaha, in Nebraska, north of the bridge, which is nearly due north of Robinson, Kan. My time was so limited that I was unable to make detailed observations except at this particular place. Coal has been mined in the very lowermost part of the bluff, a little west of the road, and a little above the base of the bluff is a stratum of massive, buff limestone which I believe to be the Burlingame. There seems to be a limestone forming a terrace about midway between the lower limestone and the top of the hill, which is probably one or more of the other members of the Burlingame system.

It is but a little way east of here to the mouth of the Great Nemaha where Hayden saw, as previously quoted, the exposure on the Missouri with the coal and sandstone in place. This is, without doubt, the same coal that is mined on the north side of the Nemaha just described, and at Robinson, and is, consequently, probably of the same horizon as the Silver Lake coal.

Meek places the Minersville (Otoe) section above that at Nebraska City, which, though unable to trace the strata from one place to the other, I think is correct. He also, provisionally, places the limestone at Rulo (the Burlingame) just above the Minersville section. I have never been over the ground between Rulo and Minersville; but the rocks at Minersville and Nebraska City are just what we should expect if Meek's correlation were correct, as a comparison will show: At the base of the section (Nebraska City) are several layers of limestone, then, above, a thick bed of shales and sandstone, coal, and limestone; then over 100 feet of shales which contain a second coal (though somewhat lower than might be expected), and on above this another limestone, which makes it agree in stratigraphic succession, as it does in fossils, with the Topeka section. Thus, considering the great care with which Meek did the work, we can but come to the conclusion that his correlation is probably correct.

If the foregoing statements are correct, we are forced to the conclusion that the Nebraska City section of Meek, from the base of the lower limestone to the top of the Minersville section, corresponds to the Topeka section from the Topeka limestone nearly to the base of the Burlingame limestone. Looked at in this light it also agrees very well with Prosser's work. It makes his remark that "These shales are mostly of a drab color, somewhat micaceous as well as clayey, and resemble those used for vitrified bricks at the Topeka, Kan., works," quite significant. The location of the Burlingame limestone at Rulo also agrees very well with his Cottonwood limestone four miles west of Auburn, Neb., 345 feet above the Missouri river. It is true that the shales corresponding to the Minersville shales in the Topeka section are less highly colored and, in places, less sandy, but on the whole I think this is of little importance in so long a distance. Besides, these highly colored shales can be correlated here as well as anywhere between the base of the Permian and the lower part of the Upper Coal Measures, which are certainly far below them, with one exception, which is considerably above the Topeka section, and here, I think, the succession of strata and the fossils are both different from the Missouri river sections.

At any rate, it can be stated with a moderate degree of certainty that the rocks at Nebraska City, Neb., and at Topeka, Kan., belong to the same general horizon.

Paleontological Laboratory, University of Kansas, November 10, 1898.